Polymer Electrolytes Based on Ionic Liquids

Andrzej Lewandowski and Agnieszka Swiderska
Faculty of Chemical Technology, Poznan University of Technology,
PL 60-965 Poznan, Poland

There has been growing interest in the development of solid state electrochemical devices, such as batteries, electrochromic displays, photogalvanic cells or chemical capacitors. Polymer electrolytes are usually used as solid electrolyte materials in such applications. Polymers may serve, just like some liquids, as solvents of electrolytes; The specific conductance is one of the major factors which determine the practical application of such electrolytes. Transport of ions through the bulk of the electrolyte must occur rapidly to achieve the high power density of an electrochemical device. To improve the ionic conductivity of polymer electrolytes, hybrid systems composed of the polymer, salt and a liquid plasticizer were prepared. In general, gel-type electrolytes can exhibit a high conductance at room temperature; among the most frequently studied are those formed by immobilising propylene carbonate and ethylene carbonate in a polymer matrix. Molten salts occupy a special position being solvent free, but otherwise possessing all of the liquid-like motional properties exhibited by solvent based electrolytes.

Many aqueous as well as organic liquid solutions of electrolytes including a limited number of polymer electrolytes have been used for the assembly of capacitors. High operating voltage and high conductivity are the main factors which determine the performance of capacitors. Electrodes of chemical capacitors are usually fabricated from activated carbons possessing specific surface area of the order of 10^3 m^2/g with the energy stored in the electric double-layer formed at the electrode/electrolyte interface. As long as the carbon electrodes are blocking, Faradaic processes are eliminated, and hence, electrolytes are electrochemically stable at a possible broad potential range.

Certain pyridinium and imidazolium chlorides react with aluminium chloride to form molten salts at room temperature. They exhibit high ionic conductivity, wide electrochemical window, non-volatility, thermal stability and non-flammability. However, chloroaluminate molten salts are moisture sensitive, and the decomposition product, HCl, is highly corrosive. Polymer gel electrolytes which contained non-chloroaluminate molten salt were prepared [1,2].

This presentation outlines the results of our work on conducting polymer electrolytes prepared by dissolving polymers in ionic liquids, based on 1-methyl-1-nbutyl pyrrolidinium and 1-ethyl-3-methyl imidazolium cations. The systems were designed to operate as electrolytes in all-solid chemical capacitors. The polymer electrolytes are flexible films with high room temperature conductivities. Both components of the electrolytes (the ionic liquids and the polymers) are nonvolatile and are thermally stable, and therefore, the foils can be operated at relatively high temperatures.

1. J. Fuller, A. C. Breda, R. T. Carlin, J. Electrochem. Soc, 144, L67 (1997)
2. A. Noda, M. Watanabe, *Electrochim. Acta*, 45, 1265 (2000)